# DETAILED PROJECT REPORT

## GRID-INTERACTIVE ROOFTOP SOLAR PHOTOVOLTAIC POWER PLANTS WITH EVACUATION ON HT SIDE(11 KV) AT FOLLOWING SITES

| SR. NO. | SITE NAME | CAPACITY OF SPV POWER PLANT |
|---|---|---|
| 1. | Post Graduate College, Sector-46, Chandigarh | 210 KWp |
| 2. | PG Govt. College for Girls, Sector-42, Chandigarh | 200 KWp |
| 3. | Govt. College for Men, Sector-11, Chandigarh | 435 KWp |
| 4. | Govt. College for Girls, Sector-11, Chandigarh | 495 KWp |
| 5. | IRB Complex, Sarangpur, Chandigarh | 200 KWp |
| 6. | Punjab Engineering College, Sector-12, Chandigarh | 1000 KWp |
| **TOTAL** | | **2540 KWp** |

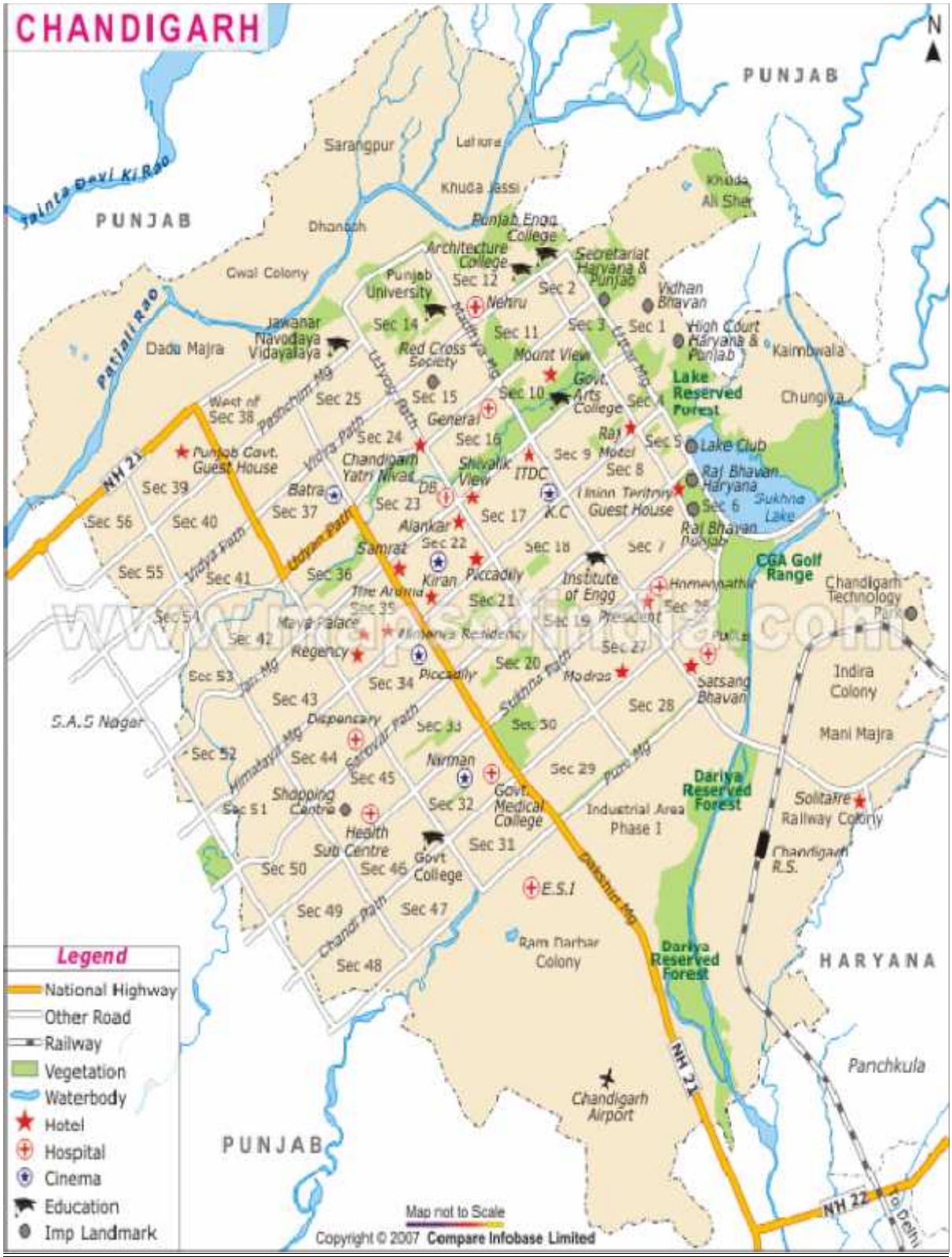
## TOTAL CAPACITY 2540KWp

***Submitted by:-***

**Chandigarh Renewal Energy and Science & Technology (CREST) Promotional Society**

**Sector 19B, Chandigarh.**

**Contact No. 0172-2703982**


CHANDIGARH
PUNJAB
HARYANA
N
Sarangpur
Lalkora
Khuda Jassi
Khuda Ali Sher
Dhanoth
Punjab Engg College
Architecture College
Secretariat Haryana & Punjab
Vidhan Bhavan
Punjab University
Sec 12
Sec 2
Sec 14
Sec 11
Sec 3
Sec 1
High Court Haryana & Punjab
Kaimbwala
Dadu Majra
Jawahar Navodaya Vidyalaya
Red Cross Society
Mount View
Govt. Arts College
Lake Reserved Forest
Chungiya
Sec 38
Sec 25
Sec 15
Sec 10
Sec 4
General
Sec 24
Sec 16
Sec 5
Lake Club
Punjab Govt. Guest House
Chandigarh Yatri Nivas
Shivalik View
ITDC
Sec 9
Sec 8
Raj Bhavan Haryana
Sec 39
Batra
DB
Sec 23
K.C
Union Territory Guest House
Sec 6
Sukhna Lake
Sec 56
Sec 40
Sec 37
Sec 17
Alankar
Raj Bhavan Punjab
Sec 22
Sec 18
Sec 7
Samrat
CGA Golf Range
Sec 55
Sec 41
Sec 36
Kiran
Piccadily
Institute of Engg
Chandigarh Technology Park
The Arawali
Sec 21
Sec 19
Sec 35
Sec 54
Maya Palace
Sec 42
Regency
Sec 20
Madras
Sec 27
Indira Colony
Sec 53
Sec 34
Piccadily
Satsang Bhavan
Sec 43
Sec 28
S.A.S Nagar
Dispensary
Sec 33
Sec 30
Mani Majra
Sec 52
Sec 44
Sec 29
Shopping Centre
Sec 45
Sec 32
Govt. Medical College
Industrial Area Phase 1
Darlya Reserved Forest
Solitaire Railway Colony
Sec 51
Health Sub Centre
Sec 31
Chandigarh R.S.
Sec 50
Sec 46
Govt College
E.S.I
Sec 49
Sec 47
Ram Darbar Colony
Sec 48
Darlya Reserved Forest
Panchkula
Chandigarh Airport
NH 21
NH 22
To Delhi
Legend
National Highway
Other Road
Railway
Vegetation
Waterbody
Hotel
Hospital
Cinema
Education
Imp Landmark
Map not to Scale
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# INDEX

# EXECUTIVE SUMMARY

Ministry of New and Renewable Energy has declared Chandigarh as a Model solar City vide letter No. 3/1/2008-UICA(SE) dated 18th.Feb.2008 for which a master plan was prepared and submitted to the Ministry for approval. The designated committee of the Ministry approved the master plan on 4th of January, 2012. The various prestigious institutions and other Govt. Buildings/Institutions have been taken up in the Master Plan for the installation of Solar Photovoltaic Power Plants and water heating systems. Based on the proposal CREST has carried out comprehensive site survey and feasibility study and have been/are being installed the system and also prepared a detailed project report for the following six (6) sites:-

| SR. NO. | SITE NAME | CAPACITY OF SPV POWER PLANT |
|---|---|---|
| 1. | Post Graduate College, Sector-46, Chandigarh | 210 KWp |
| 2. | PG Govt. College for Girls, Sector-42, Chandigarh | 200 KWp |
| 3. | Govt. College for Men, Sector-11, Chandigarh | 435 KWp |
| 4. | Govt. College for Girls, Sector-11, Chandigarh | 495 KWp |
| 5. | IRB Complex, Sarangpur, Chandigarh | 200 KWp |
| 6. | Punjab Engineering College, Sector-12, Chandigarh | 1000 KWp |
| **TOTAL** | | **2540 KWp** |

The brief history and location/site details of the above sites is as under:-

## 1. Post Graduate College, Sector-46, Chandigarh:

The college was established in 1982, Postgraduate Government College, Sector 46, is relatively young but offers an array of fine higher educational options in various streams namely Arts, Commerce and Computer Applications, with Honours in selected subjects. The college also offers masters in Commerce. Accredited with B+ by NAAC, the college has faculty with impeccable credentials and upgraded knowledge that prepares the students to become diligent citizens and hold leadership positions. The Department of Science & Technology (DST) of UT Govt. has installed 210 KWp SPV Power Plant on the rooftop of this building.

# LOCATION / SITE DETAILS OF THE PROJECT

| | |
|---|---|
| Address of site | Post Graduate College, Sector-46, Chandigarh |
| Access<br>Railhead<br>Road | <br>Chandigarh Railway Station<br>Sector- 46 |
| Location | Chandigarh |
| Ownership | Owned by UT., Govt. |
| Other meteorological parameters<br>Ambient temperature<br><br>Latitude<br>Longitude | 44degree Celsius max., 4 degree min.<br><br><br>30 degree 69'N<br>76 degree 73' E |
| Elevation | 238 Mtr. Above mean sea level |
| Tilt Angle | 13 degree |
| Feeding point | At the College on HT side within the premises |

**2. PG Govt. College for Girls, Sector-42, Chandigarh:**

PG Government College for Girls, Sector-42, is situated in southern part of Chandigarh- the City Beautiful. The College with its impressive building and rich infrastructure caters to the academic and professional needs of girls not only from Chandigarh and adjoining rural areas but also from different states of India. The college was established in the year 1982. At the initial stage there were 300 students and 20 teachers in the college. The science faculty was added in the year 1989. The college is affiliated to the Punjab University, Chandigarh. At present there are 150 teaching faculty members who provide quality education to about 3500 students. A twenty nine year old college, serving the cause of women empowerment, has entered the stage of confidence and optimism. The Department of Science & Technology (DST) of UT Govt. has installed 200 KWp SPV Power Plant on the rooftop of this building.

# LOCATION / SITE DETAILS OF THE PROJECT

| | |
|---|---|
| Address of site | Govt. College for Girls, Sector-42, Chandigarh |
| Access<br>Railhead<br>Road | <br>Chandigarh Railway Station<br>Sector- 42 |
| Location | Chandigarh |
| Ownership | Owned by UT., Govt. |
| Other meteorological parameters<br>Ambient temperature<br><br>Latitude<br>Longitude | 44degree Celsius max., 4 degree min.<br><br><br>30 degree 69'N<br>76 degree 73' E |
| Elevation | 238 Mtr. Above mean sea level |
| Tilt Angle | 13 degree |
| Feeding point | At the college on HT side within the premises |

### 3. Govt. College for Men, Sector-11, Chandigarh:

Government College, Sector 11,Chandigarh was established in 1953. It was shifted to its present campus in 1960. Froma sapling, it has grown into a leading institution having its own distinct impresson the educational and cultural life of the city beautiful. It now imparts instruction in Humanities, Computer Application, Biotechnology (Three year Course), Science, Commerce, Business Administration and Post-graduation in English and Information Science. In recognition of its outstanding all round performance the college has been accredited with B++ grade by the National Assessment and Accreditation Council (NAAC). The Department of Science & Technology (DST) of UT Govt. has installed 435 KWp SPV Power Plant on the rooftop of this building.

## LOCATION / SITE DETAILS OF THE PROJECT

| | |
|---|---|
| Address of site | Govt. College for Men, Sector-11, Chandigarh |
| Access<br>Railhead<br>Road | <br>Chandigarh Railway Station<br>Sector- 11 |
| Location | Chandigarh |
| Ownership | Owned by UT., Govt. |
| Other meteorological parameters<br>Ambient temperature<br><br>Latitude<br>Longitude | 44degree Celsius max., 4 degree min.<br><br><br>30 degree 69'N<br>76 degree 73' E |
| Elevation | 238 Mtr. Above mean sea level |
| Tilt Angle | 28 degree |
| Feeding point | At the college on HT side within the premises |

**4. Govt. College for Girls, Sector-11, Chandigarh:**

Govt. College for Girls, Sector 11, Chandigarh is the oldest institution in the city with a total strength 4000 students where 600 students are living in the three hostels. The total connected load of this institution is 3400 KW. The 11KV line is coming from Main Grid to the Sub Station of the institution and after step-downing to 440 Volts it is being distributed to all buildings in this campus. In recognition of its outstanding all round performance the college has been accredited with A grade by the National Assessment and Accreditation Council (NAAC). The Department of Science & Technology (DST) of UT Govt. are being installed 495 KWp SPV Power Plant on the rooftop of this building.

# LOCATION / SITE DETAILS OF THE PROJECT

| | |
|---|---|
| Address of site | Govt. College for Girls, Sector-11, Chandigarh |
| Access<br>Railhead<br>Road | <br>Chandigarh Railway Station<br>Sector- 11 |
| Location | Chandigarh |
| Ownership | Owned by UT., Govt. |
| Other meteorological parameters<br>Ambient temperature<br><br>Latitude<br>Longitude | 44degree Celsius max., 4 degree min.<br><br><br>30 degree 69'N<br>76 degree 73' E |
| Elevation | 238 Mtr. Above mean sea level |
| Tilt Angle | 28 degree |
| Feeding point | At the this College on HT side within the premises |

**5. IRB Complex, Sarangpur, Chandigarh:**

Police Establishment at Sarangpur., Chandigarh with a total strength 600 Trainees are living in these establishments. The site identified for the purpose of setting up the SPV Power Plants is the rooftops of prefab structure i.e. Portable Cabin in the Police Establishment at Sarangpur. The project shall demonstrate rooftop Solar systems for power generation. The project shall demonstrate rooftop Solar systems for power generation on prefab instructress Portable Cabins, under model solar city programme. The Department of Science & Technology (DST) of UT Govt. are being installed 200 KWp SPV Power Plant on the rooftop of these portable cabin in this establishment.

# LOCATION / SITE DETAILS OF THE PROJECT

| | |
|---|---|
| Address of site | IRB Complex, Sarangpur, Chandigarh |
| Access<br>Railhead<br>Road | <br>Chandigarh Railway Station<br>Sarangpur |
| Location | Chandigarh |
| Ownership | Owned by UT., Govt. |
| Other meteorological parameters<br>Ambient temperature<br><br>Latitude<br>Longitude | 44degree Celsius max., 4 degree min.<br><br><br>30 degree 69'N<br>76 degree 73' E |
| Elevation | 238 Mtr. Above mean sea level |
| Tilt Angle | 15 degree |
| Feeding point | At the complex on HT side within the premises |

**6. Punjab Engineering College, Sector-12, Chandigarh:**

Punjab Engineering College (PEC), Chandigarh a Deemed University, is one of the pioneer institutions of India. Since its inception, the institute has oriented itself towards reaching the zenith in educational excellence. The college enjoys a distinct position of leadership in the field of technology and has become a national leader in imparting technical education with a total strength 3000 students (approx) where 1050 students are living in the six hostels. The Department of Science & Technology (DST) of UT Govt. are being installed 1000 KWp SPV Power Plant on the rooftop of this building.

## LOCATION / SITE DETAILS OF THE PROJECT

| | |
|---|---|
| Address of site | Punjab Engineering College, Sector-12, Chandigarh |
| Access<br>Railhead<br>Road | <br>Chandigarh Railway Station<br>Sector- 12 |
| Location | Chandigarh |
| Ownership | Owned by UT., Govt. |
| Other meteorological parameters<br>Ambient temperature<br><br>Latitude<br>Longitude | 44degree Celsius max., 4 degree min.<br><br><br>30 degree 69'N<br>76 degree 73' E |
| Elevation | 238 Mtr. Above mean sea level |
| Tilt Angle | As per roof / space available |
| Feeding point | At the college on HT side within the premises |

These projects shall demonstrate rooftop SPV systems technology for power generation in Institutions, under model solar city programme.

## SOCIO-ECONOMIC JUSTIFICATION

There are growing trends in setting up grid interactive power plants worldwide. In grid interactive mode the solar power can be utilised to its full potential. All the requirements are being fulfilled by the site conditions of Govt. Schools, in Chandigarh. Chandigarh is the UT which has no other source of power generation except roof top SPV power generation. This project will help in adding the power in UT grid thus indirectly will reduce the import of power from other sources.

- Abundant sun light is available.
- Grid availability is high.
- Technical staff is available for care taking the technical things.
- Round the clock security is available.
- The project will be installed and taken care by the highly professional team of the CREST and UT. Govt. Department of Electrical Engineering.
- The power produced by this project will be directly fed to LT side.

- Bidirectional meter will be installed to measure the import and export of solar power.

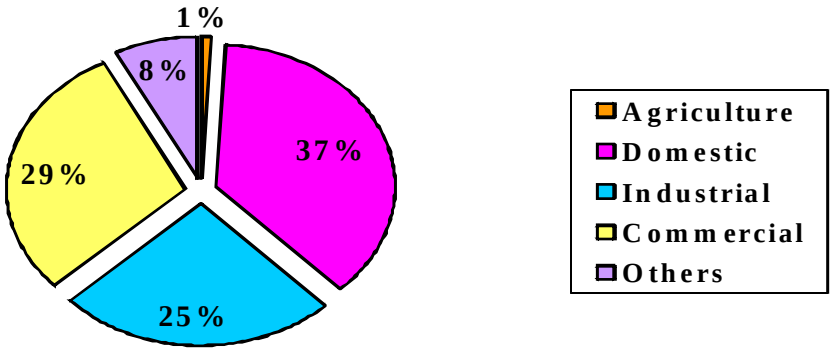
## BENEFITS FROM THE PROJECT

Since, Chandigarh is the UT which has no other source of power generation except roof top SPV power generation. This project will help in adding the power in UT grid thus indirectly will reduce the import of power from other sources.

## POWER SCENARIO IN CHANDIGARH

Union Territory Chandigarh is receiving power from different resources approx. 350 MW such as Bhakra Beas Management Board - 39%, National Thermal Power Corporation - 35%, National Hydroelectric Power Corporation Ltd. (NHPC) - 14%, Naptha Jhakri Power Corporation Ltd. (NJPC) - 05%, Punjab Trading Corporation (PTC) - 03%, Teri Hydro Development Company Ltd. – 02%, National Atomic Power (APS) – 01%, Rajasthan Atomic Power (RAPS) – 01%.

# SECTOR WISE POWER CONSUMPTION IN UT CHANDIGARH



# NAME OF THE PROJECT PROPONENT

**CREST**

| | | |
|---|---|---|
| 1 | Name, designation and Complete address of the Authorised representative for correspondence | Sh. Santosh Kumar<br>Chief Executive Officer<br>Chandigarh Renewal Energy, Science and Technology Promotion Society (CREST), Sector-19B, Chandigarh |
| 2 | Telephone Number | +91-2703982 |
| 3 | FAX Number | 0172-2703982 |
| 4 | E-mail | crestchandigarh@gmail.com |

**CATEGORY OF PROJECT PROPONENT: STATE RENEWABLE ENERGY DEVELOPMENT AGENCY**

**UNDER**

**DEPARTMENT OF SCIENCE & TECHNOLOGY, CHANDIGARH (DST):**

| | | |
|---|---|---|
| 1 | Name, designation and Complete address of the Nodal Officer | Sh. Santosh Kumar<br>Director, Deptt. Of Science & Technology, Sector-19B, Chandigarh. |
| 2 | Telephone Number | +91-9463998525 |
| 3 | FAX Number | 0172-2703982 |
| 4 | E-mail | dstchandigarh17@gmail.com |

# IMPLEMENTING AGENCY

The project have been / are being executed by the Professional staff of Chandigarh Renewal Energy Science & Technology Promotional Society (CREST), Department of Science & Technology, in co-ordination with Electrical Engineering Department of U.T., Chandigarh.

# PART - B

# TECHNICAL DETAILS

# TECHNICAL AND TECHNOLOGY ARRANGEMENTS / FACILITIES FOR SPV POWER PLANTS

**Name of the Work:**

Design, Manufacturing, Supply, Erection, Testing & Commissioning along-with Operation and Maintenance of 10 years for Grid Interactive Rooftop SPV Power Plants as per manufacturers designs and power evacuation on HT side as per the following details:

| SL. NO. | SITE NAME | CAPACITY OF SPV POWER PLANT |
|---|---|---|
| 1. | Post Graduate College, Sector-46, Chandigarh | 210 KWp |
| 2. | Govt. College for Girls, Sector-42, Chandigarh | 200 KWp |
| 3. | Govt. College for Men, Sector-11, Chandigarh | 435 KWp |
| 4. | Govt. College for Girls, Sector-11, Chandigarh | 495 KWp |
| 5. | IRB Complex, Sarangpur, Chandigarh | 200 KWp |
| 6. | Punjab Engineering College, Sector-12, Chandigarh | 1000 KWp |

**Solar Photovoltaic Modules**

The total solar PV array capacity should not be less than the SPV plant capacity on max. Radiation day and shall be comprise of solar mono / multi crystalline modules of minimum 250 watts. The Photovoltaic modules shall be tested **& approved by one of the IEC authorized test centers , Test Certificates can be from any of the NABL / BIS accredited testing / calibration laborites** the module type must be qualified as per IEC 61215( Second Edition). In addition PV modules must qualify to IEC 61730 Part I to II for safety qualification testing. SPV module conversion efficiency shall be greater than 14% under STC.

1. The PV module shall perform satisfactorily in humidity up to 100 % with temperature between (-) 10 deg. C to + 85 deg. C. Since the modules would be used in a high voltage circuit, the high voltage insulation test shall be carried out on each module and a test certificate to the effect provided.

2. The module shall have warranty of 25years with degradation of power generated not exceeding 20% of the minimum rated power over the 25 years period and not more than 10% after 10 years period as per MNRE guidelines.

3. Other general requirements for the PV modules and subsystems shall be the following:

   a) Raw materials and technology employed in the module production processes shall not be considered relevant so long as the given specifications are satisfied.
   b) The rated output power of any supplied module shall not have negative tolerance.
   c) The peak-power point voltage and the peak-power point current of any supplied module and/or any module string (series connected modules) shall not vary more than 3 (three) per cent from the respective arithmetic means for all modules and/or for all module strings, as the case may be.
   d) Except where specified, the front module surface shall consist of impact resistant, low-iron and high-transmission toughened glass.

e) The module frame, if any, shall be made of a corrosion-resistant material which shall be electrolytically compatible with the structural material used for mounting the modules.
f) The module shall be provided with a junction box with provision of external screw terminal connection and with arrangement for provision for by-pass diode. The box shall have hinged, weather proof lid with captive screws and cable gland entry points of may be of sealed type.
g) Necessary I-V curves are required to be furnished along with the SPV modules.

**h) IDENTIFICATION AND TRACEBILITY**

Each PV module used in any solar power project must use a **RF Identification Tag (RFID)**, which must contain the following Information. The RFID will be inside, the module laminated, but must be able to withstand harsh environmental Conditions

i. Name of the manufacturer of PV Module
ii. Name of the manufacturer of solar cells
iii. Month and year of the manufacturer (separately for solar cells and modules.
iv. Country of Origin (separately for solar cells and modules
v. I-V Curve for the module
vi. Peak wattage , Im , Vm and FF for the module
vii. Unique Serial No and Model No of the Module
viii. Date and year of obtaining IEC PV module qualification certificate.
ix. Name of the test lab issuing IEC certificate

**2. ARRAY STRUCTURE**

PV PANEL STRUCTURES

i. Wherever required, Suitable number of PV panel structures shall be provided. Structures shall be of flat-plate design with combination of I , C and L sections as per structure design requirement.

ii. Structural material shall be corrosion resistant and electrolytically compatible with the materials used in the module frame, its fasteners, nuts and bolts. Galvanizing should meet ASTM A-123 hot dipped galvanizing or equivalent which provides at least spraying thickness of 70 microns as per IS5909, if steel is used.

iii. Aluminum extruded frame structures with adequate strength and in accordance with relevant BIS standards can also be used with proof that the design of the structure can withstand the wind speed of 170 km per hour as per BIS Standards.

iv. Structures shall be supplied complete with all members to be compatible for allowing easy installation at the rooftop site.

V. The Structure shall be made out of either Galvanized steel or Aluminum member as per design to be submitted by firm. The structures shall be designed to allow easy replacement of any module.

VI. Each structure should have angle of inclination as per the site conditions as well as from

aesthetic consideration keeping in view of Chandigarh's building aesthetic look.

VII. Each panel frame structure be so fabricated as to be fixed on the rooftop column/wall structures. The structure should be capable of withstanding a wind load of 170 km/hr after grouting & installation. The front end of the solar array should not be less than 30 cms from the roof. Grouting material for SPV structure shall be as per M15 (1:2:4) concrete specification.

VIII. The structures shall be designed for simple mechanical and electrical installation. There shall be no requirement of welding or complex machinery at the installation site. If prior civil work or support platform is absolutely essential to install the structures, the supplier shall clearly and unambiguously communicate such requirements along with their specifications in the bid. Detailed engineering d drawings and instructions for such prior civil work shall be carried out prior to the supply of Goods.

IX. The supplier shall specify installation details of the PV modules and the support structures with appropriate diagrams and drawings. Such details shall include, but not limited to, the following;

a) Determination of true south at the site;
b) Array tilt angle to the horizontal, with permitted tolerance;
c) Details with drawings for fixing the modules;
d) Details with drawings of fixing the junction/terminal boxes;
e) Interconnection details inside the junction/terminal boxes;
f) Structure installation details and drawings;
g) Electrical grounding (earthing);
h) Inter-panel/Inter-row distances with allowed tolerances; and
i) Safety precautions to be taken.

IX. As per need of aesthetic look, the structure may be kept as non penetrating type on roofs of building having low height (one or two storey).

X. The array structure shall support SPV modules at a given orientation and absorb and transfer the mechanical loads to the rooftop columns properly. All nuts and bolts shall be of very good quality stainless steel except foundation bolts which will be of MS (GI Coated).

**3. POWER CONDITIONING UNIT ( STRING INVERTORS)**

The power conditioner unit totalling not less than the SPV Power Plant capacity i.e.1000 KVA for 1000 KWp, 495 KVA for 495 KWp, 435 KVA for 435 KWp, 210 KVA for 210 KWp, 200 KVA for 200 KWp have been/are being provided to convert DC power produced by SPV modules, in to AC power. The power conditioning unit in multiples string Invertors. The individual Inverter are not be less than 10 KVA. Grid interactive solar inverter with a highly efficient conversion unit having minimum following specifications:

Type : Self commuted, current regulated, high frequency IGBT based with Trench Gate Structure

| | |
|---|---|
| Output voltage | : 3 phase, 415 V ac (+12.5 %, - 20 % V ac) |
| Frequency | : 50 Hz ±1 Hz |
| Continuous rating | : Not less than SPV Power Plant capacity |
| DC input Operating range | : 200 V to 800 V nominal |
| Total Harmonic Distortion | : less than 3 % |
| Operating temperature Range | : 0 to 55 deg C |
| Housing cabinet | : PCU to be housed in suitable cabinet with minimum IP 65 standard. |
| Inverter efficiency | : >95 % at full load. |
| Power Control | : MPPT |

**Other important Features/Protections required in the PCU**

- Authentic tracking of the solar arrays maximum power operation voltage (MPPT).
- Array ground fault detection.
- LCD and piezoelectric keypad operator interface Menu driven.
- Automatic fault conditions reset for all parameters like voltage, frequency and/or black out.
- MOV type surge arresters on AC and DC terminals for over voltage protection from lightning-induced surges.
- PCU should be rated to operate at 0 to 55 deg. Centigrade above ambient temp
- All parameters should be accessible through an industry standard communication link.
- The PCU should go in sleep mode when there is no grid supply.

3.1 Since the PCU is to be used in solar photo voltaic energy system, it should have high operational efficiency. The idling current at no load must not exceed 2 percent of the full-load current.

3.2 There shall be a direct current isolation provided at the output by means of a suitable isolating transformer.

3.3 The PCU output shall be 415 VAC, 50 Hz 3 phase.

3.4 The PCU shall include appropriate self protective and self diagnostic features to protect itself and the PV array from damage in the event of PCU component failure or from parameters beyond the PCU's safe operating range due to internal or external causes. The self-protective features shall not allow signals from the PCU front panel to cause the PCU to be operated in a manner which may be unsafe or damaging. Faults due to malfunctioning within the PCU, including commutation failure, shall be cleared by the PCU protective devices and not by the existing site utility grid service circuit breaker.

The PCU shall go to shut down/standby mode, with its contacts open, under the

following conditions before attempting an automatic restart after an appropriate time delay; in sufficient solar power output etc.

a) Insufficient Solar Power Input.

When the power available from the PV array is insufficient to supply the losses of the PCU, the PCU shall go to a standby/shutdown mode. The PCU control shall prevent excessive cycling during rightly shut down or extended periods of insufficient solar radiation.

The power conditioning units / inverters should be applicable IEC/ equivalent BIS standard for efficiency measurement and environmental testing as per standard code IEC 61683 and IEC 60068 2(6,21,27,30,75,78) and drop test (IEC 60068-2-26). The charge controller/ MPPT units should qualify IEC 62093 and IEC 60068 2 (6,21,27,30,75,78). The junction boxes/ enclosures should be IP 65 (for outdoor)/ IP 54 (indoor) and as per IEC 62208 specifications.

The PCU's should be tested from the MNRE approved test centres / NABL /BIS accredited testing- calibration laboratories. In case of imported power conditioning units, these should be approved by international test houses. Party must supply and upload the test report of PCU /inverter along with the tender document.

**b) Utility-Grid Over or Under Frequency**

The PCU shall restart after an over or under frequency shutdown when the utility grid voltage has returned to the within limits for minimum of two minutes.

3.6 The PCU generated harmonics measures at the point of connection to the utility services when operating at the rated power shall not exceed a total harmonic current distortion of 3 percent, a single frequency current distortion of 3 percent and single frequency voltage distortion of 1 percent, when the first through the fiftieth integer harmonics of 50 Hz are considered.

3.7 The PCU Power factor at the point of utility service connection shall be 0.95 lagging or leading when operating at above 25 percent of the rated output, but may be less than 0.95 lagging below 25 percent of the rated output.

3.8 The high voltage and power circuits of the PCU shall be separated from the low-voltage and control circuits. All conductors shall be made of standard copper.

3.9 The PCU shall withstand a high voltage test of 2000 V rms, between either the input or the output terminals and the cabinet (chassis).

3.10 Full protection against accidental open circuit and reverse polarity at the input shall be provided.

3.11 The PCU shall not produce Electromagnetic Interference (EMI) which may cause malfunctioning of electronic and electrical instruments including communication equipment, which are located within the facility in which the PCU is housed.

3.12 The PCU shall have an appropriate display on the front panel to display the instantaneous AC power output and the DC voltage, current and power input. The display shall be visible from outside the PCU enclosure. Operational status of the PCU, alarms, trouble indicators and ac and the dc disconnect switch positions shall also be communicated by appropriate messages or indicator lights on the front cover of the PCU enclosure.

**3.13 Electrical safety, earthing and protection:**

A) Internal Faults: In built protection for internal faults including excess temperature, commutation failure, overload and cooling fan failure (if fitted) is obligatory.

B) Galvanic Isolation: Galvanic Isolation is required to avoid any DC component being injected into the grid and the potential for AC components appearing at the array.

C) Over Voltage Protection: Over Voltage Protection against atmospheric lightning discharge to the PV array is required. Protection is to be provided against voltage fluctuations in the grid itself and internal faults in the power conditioner, operational errors and switching transients.

D) Earth fault supervision: An integrated earth fault device shall have to be provided to detect eventual earth fault on DC side and shall send message to the supervisory system.

E) Cabling practice: Cable connections must be made using PVC Cu cables, as per BIS standards. All cable connections must be made using suitable terminations for effective contact. The PVC Cu cables must be run in GL trays with covers for protection.

F) Fast acting semiconductor type current limiting fuses at the main bus-bar to protect from the grid short circuit contribution.

3.14 The PCU shall include an easily accessible emergency OFF button located at an appropriate position on the unit.

3.15 The PCU shall include ground lugs for equipment and PV array grounding. The DC circuit ground shall be a solid single point ground connection in accordance with WEC 69042.

3.16 All exposed surfaces of ferrous parts shall be thoroughly cleaned, primed, and painted or otherwise suitably protected to survive a nominal 30 years design life of the unit.

3.17 The PCU enclosure shall be weatherproof and capable of surviving *climatic changes and should keep the PCU* intact under all conditions in the room where it will be housed. *The PCU located indoor should be floor mounted*. In case of String Invertors , it will be installed as per the manufacturer design for which prior approval will be taken from the CREST. Moisture condensation and entry of rodents and insects shall be prevented in the PCU enclosure.

3.18 Components and circuit boards mounted inside the enclosures shall be clearly identified with appropriate permanent designations, which shall also serve to identify the items on the supplied drawings.

3.19 All doors, covers, panels and cable exists shall be gasketed or otherwise designed to limit the entry of dust and moisture. All doors shall be equipped with locks. All openings shall be provided with grills or screens with openings no larger than 0.95 cm.

3.20 The design and fabrication of the PCU the site temperature ($0^{O}$ to $70^{O}$ C), incident sunlight and the effect of ambient temperature on component life shall be considered carefully. Similar consideration shall be given to the heat sinking and thermal for blocking diodes and similar components.

### 3.21 Factory Testing:

A) Preparation of all controls, protective and instrumentation circuits shall be demonstrated by direct test if feasible or by simulation operation conditions for all parameters that cannot be directly tested.

B) Operation of start up, disconnect and shutdown controls shall also be tested and demonstrated. Stable operation of the PCU and response to control signals shall also be tested and demonstrated.

C) Factory testing shall include measurement of phase currents, efficiencies, harmonic content and power factor.

D) A factory Test Report (FTR) shall be supplied along with the unit. The FTR shall include detailed description of all parameters tested qualified and warranted.

### 3.22 Operating Modes:

The following operating modes are to be made available:

Night or Sleep mode: Where the inverter is almost completely turned off, with just the timer and control system still in operation, losses should not exceed 2 watts per 5 kilowatt.
**In case of Grid Failure, the PCU should go in sleep mode/ turned off immediately.**

Standby mode : Where the control system continuously monitors the output of the solar generator until pre-set value is exceeded (typically 20 watts)

Operational or MPP tracking mode : The control system continuously adjust the voltage of the generator to optimize the power available. The power conditioner must automatically re-enter stand-by mode when input power reduces below the standby mode threshold. Front Panel display should provide the status of the PCU, including AC Voltage, Current, Power output & DC Current, Voltage and Power input, pf and fault Indication (if any)

### 3.23 Codes and Standards

The quality of equipment supplied shall be controlled to meet the guidelines for engineering design included in the standards and codes listed in the relevant ISI and other standards, such as :

IEEE 928 Recommended Criteria for Terrestrial PV Power Systems.

IEEE 929 Recommended Practice for Utility Interface of Residential and Intermediate PV Systems.

IEEE 519 Guide for Harmonic Control and Reactive Compensation of Static Power Controllers.

National Electrical NEPA 70-(USA) or equivalent national standard.

National Electrical Safety Code ANSI C2- (USA) or equivalent national standard.

JRC Specification 503 (Version 2.2 March 1991) or JPL Block V standard for PV modules.

## 3.24. METERING

1. PV array energy production: Digital Energy Meters to log the actual value of AC/ DC Voltage, Current & Energy generated by the PV system shall have to be provided for each SPV plant.
2. Solar Irradiance: An integrating Pyranometer (Class II or better) should be provided for each SPV plant, with the sensor mounted in the plane of the array. Readout should be integrated with data logging, system.
3. Wind Speed: An integrated wind speed measurement unit be provided for each SPV plant.
4. Temperature: Temperature probes for recording the Solar panel temperature and ambient temperature provided for each SPV plant.
5. A data logging system for each SPV Power Plant control and monitoring shall be provided. For remote date monitoring of the plant parameters the PC shall be provided with complete functional software and remote linkage access through service provider for call / email / data transfer / IP linkage for plant operations monitoring throughout the 10 years operation & maintenance period shall be provided.
6. Class(0.5), bidirectional Energy Meter (Make L&T/Secure/Capital) be provided, along with necessary CTs/PTs at each SPV Power Plant.

All major parameters shall be available on the digital bus and logging facility for energy auditing through the internal microprocessor and can be read on the digital front panel at any time the current values, previous values for up to a month and the average values. The parameters should be accessible via the operating interface display.

Protective function limits (Viz-AC Over voltage, AC Under voltage, Over frequency, Under frequency ground fault, PV starting voltage, PV stopping voltage, Over voltage delay, Under voltage delay over frequency, Ground fault delay, PV starting delay, PV stopping delay).

## 4. TRANSFORMER:

Dry type 11KV/415V, 50 Hz Step up Transformer i.e. 1000 KVA for 1000 KWp, 630 KVA for 495 KWp, 400 KVA for 435 KWp, 250 KVA for 210 KWp,and 250 KVA for 200 KWp alongwith all protections, Switchgears, Vacuum Circuit Breakers, Cable etc. are being installed.

## BALANCE OF SYSTEM

### 5. ARRAY JUNCTION BOX(AJB)/ DC Distribution Box

Array Junction Box / DC Distribution Box to receive the DC output from the array field with provision of SPD (surge protection device) and Diode circuit or Fuse. Each inverter have independent Array Junction Box. AJB/ DC distribution board is complying with IP-65 standard.

### 6. COMMON AC DISTRIBUTION PANEL BOARD(ACDPB)

6.1. Common AC Distribution Panel Board (DPB) shall control the AC power from inverter. AC Distribution panel (ACDP) shall consist of MCCB of required capacity as incomer and suitable numbers of MCCB of appropriate capacity with appropriate

breaking capacity out going switches. The panel should be provided 3 Phase copper bus bar of suitable capacity. There shall also be the provision for remote switching so that the delivered power can be controlled from a centralized Push Button (PB) station which is called Plant Control Unit.

6.2 Common AC DPB shall have the arrangement for measuring all electrical quantities such as Voltage, Current, Frequency, of different feeder line & energy supplied to the different feeder or main feeder. DPB shall have the provision of visual indication of existence of power input & output through MIMIC diagram. Common AC DPB shall have sheet iron enclosure of dust & vermin proof & shall have adequate cooling arrangement. The bus-bars are to be made of copper of desired size. Design & Drawing is to be submitted before manufacturer assembly on installation for obtaining necessary approval from Engineer-in-Charge.

6.3 The panel will be having space for 3 Phase Bi-directional meter.

## 7. CABLES:-

a) ISI marked as per given brands PVC/XLPE insulated Copper Cond. Cable of various sizes as per load requirement for connecting all the modules / arrays to Jn. Boxes and from Jn. Boxes to DC distribution box and from DC distribution box to inverter. Copper/ Aluminium armoured Cables of appropriate size from Inverter onwards in A.C. side

b) Cabling in the yard and control room : Cabling in the yard shall be carried out as per IE Rules. Cabling inside control room and array area should be in cable pipes with proper water/moisture protection sealing. All other cabling above ground should be suitably mounted on cable trays with proper covers..

c) Wires : Only copper wires of appropriate size and of reputed make shall have to be used. On D.C. side only D.C. solar Cu cable to be used.

However aluminium cables can be used on A.C side of transmission.

d) Cables Ends: All connections are to be made through suitable cable/lug/terminals; crimped properly & with use of Cable Glands.

e) Cable Marking : All cable/wires are to be marked with proper manner by good quality ferule or by other means so that the cable can be easily identified.

All the Cu/Al. PVC or XLPE insulated Armoured Sheathed cables required for the plant will be provided by the manufacturer. However Cables for both D.C/A.C as per brands and specifications mentioned can be used. All cable schedules/layout drawings will be approved by CREST prior to installation.

## 8. LIGHTNING PROTECTION

There shall be the required number of suitable lightning arrestors installed in the array area. Lightning protection shall be provided by the use of metal oxide arrestors and suitable earthing such that induced transients find an alternate route to earth. Protection shall meet the safety rules as per Indian Electricity Act **.**

## 9. EARTHING PROTECTION

Each array structure of the PV yard should be grounded/ Earthing properly as per IS:3043-1987.In addition the lighting arrester/masts should also be provided inside the array field. Provision should be kept for shorting and grounding of the PV array at the time of maintenance work. All metal casing/shielding of the plant should be thoroughly grounded in accordance with Indian electricity Act./IE Rules. Earth Resistance should be tested in presence of the representative of Department after earthing by calibrated earth tester. PCU ACDB and DCDB should also be earthed properly.

## 10. COMPREHENSIVE MAINTENANCE

All the equipments (Except SPV Modules for which the guarantee period is 25years) shall be provided with comprehensive Maintenance for 10 years against unsatisfactory performance and/or break down due to defective design, workmanship of material. The equipments or components, or any part thereof, so found defective during Comprehensive Maintenance period shall be forthwith repaired or replaced free of cost to the satisfaction of the Engineer-in-charge.

## 11. JET PUMP 1/2 HP ( CROMPTON/ KIRLOSKOR)

Suitable No. of 1/2 HP, BIS approved surface pump have been installed Suitable Nos of water outlets have been provided through B-class ISI Marked GI Pipes for cleaning of the modules

## 12. EXPECTED ELECTRICAL ENERGY GENERATION:

The minimum expected electrical energy generation is 1300 (Kwh) per year per 1 KWp System on LT/HT side for 10 years period.

# OPERATION AND MAINTENANCE

**SCOPE OF OPERATION & MAINTENANCE OF SPV POWER PLANT FOR A PERIOD OF 10 YEAR FROM DATE OF COMMISSIONING**

Regular operation & maintenance of the SPV Power Plant for a period of ten years after commissioning along with supply of consumable items as and when necessary and submission of daily performance data of the power plant shall come, under the operation & maintenance contract.

The break down maintenance of the entire system including supply of necessary spare parts, if any, are already under the coverage of warranty clause of the specific condition for a period of 120 months from date of commissioning of power plant.

## PERFORMANCE MONITORING MECHANISM

Details of data monitoring on Daily, Monthly and Annual energy generation (data logging and compilation and sharing with MNRE)

| | |
|---|---|
| Own mechanism | The remote monitoring system with the project from where data of each inverter can be accessed through internet/GPRS system. |
| Third party | |
| Remote monitoring | |